

Walking is more effective than yoga at
reducing sleep disturbance in cancer patients :
A systematic review and meta-analysis of
randomized controlled trials

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緣起



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Introduction-1

- **Sleep disturbance** is detrimental to cancer patients and associated with increased **psychological** distress, impaired **physical function**, and high **mortality rates**.
- **Sleep medication** is the most commonly prescribed therapy for sleep disturbed cancer patients, but the **safety and effectiveness** of pharmacologic treatments have not been established in this population.
- Furthermore, evidence suggests that the use of **non-pharmacological treatments** might be more beneficial for relieving sleep disturbance.

Introduction-2

- **Exercise** is commonly recommended to treat sleep disturbance.
- Several systematic reviews indicated that **regular exercise** improves cancer patients' **sleep quality** and **quality of life**.
- Additionally, these reviews included an overly wide spectrum of **non-pharmacological interventions** ranging from **Tai chi**, **Qigong**, and **behavioral therapy** to **music therapy**.
- Previous studies have shown that **walking** and **yoga** are the most common physical exercises used to treat sleep disturbance, and both are **safe** and **feasible** for cancer patients .

Hypothesis

- Walking is more effective than yoga at reducing sleep disturbance in cancer patients.



Method - Literature search



- search of articles from January **1997** to January **2018**
- Database : **PubMed**, **EMBASE**, **CINAHL**, **Cochrane Library**, **Airiti Library**, National Digital Library of Theses and Dissertations in Taiwan, and the China Knowledge Resource Integrated (**CNKI**).
- The following keyword combinations were used in the searches:
((**“neoplasms”** [MeSH Terms] OR “neoplasms” [All Fields] OR **“cancer”** [All Fields]) AND (**“walking”** [MeSH Terms] OR “walking” [All Fields])) AND (**“sleep”** [MeSH Terms] OR “sleep” [All Fields]), ((“neoplasms” [MeSH Terms] OR “neoplasms” [All Fields] OR “cancer” [All Fields]) AND (“sleep” [MeSH Terms] OR “sleep” [All Fields])) AND (**“yoga”** [MeSH Terms] OR “yoga” [All Fields]).

Inclusion criteria

- studied sample : **adult** patient with any **cancer diagnosis**, including survivors who completed cancer treatments
- **intervention** characteristic : at least one intervention group performing **walking** or **yoga**
- **control group** : inclusion of a group that **did not perform** walking or yoga or did not perform walking or yoga until after the RCT (**wait-list**)
- Study outcome : change in **sleep disturbance** after the intervention
- **RCT** design
- only **full-text articles** written in **Chinese or English**.

Search results

- Of **998** identified studies, **25** met the inclusion criteria.

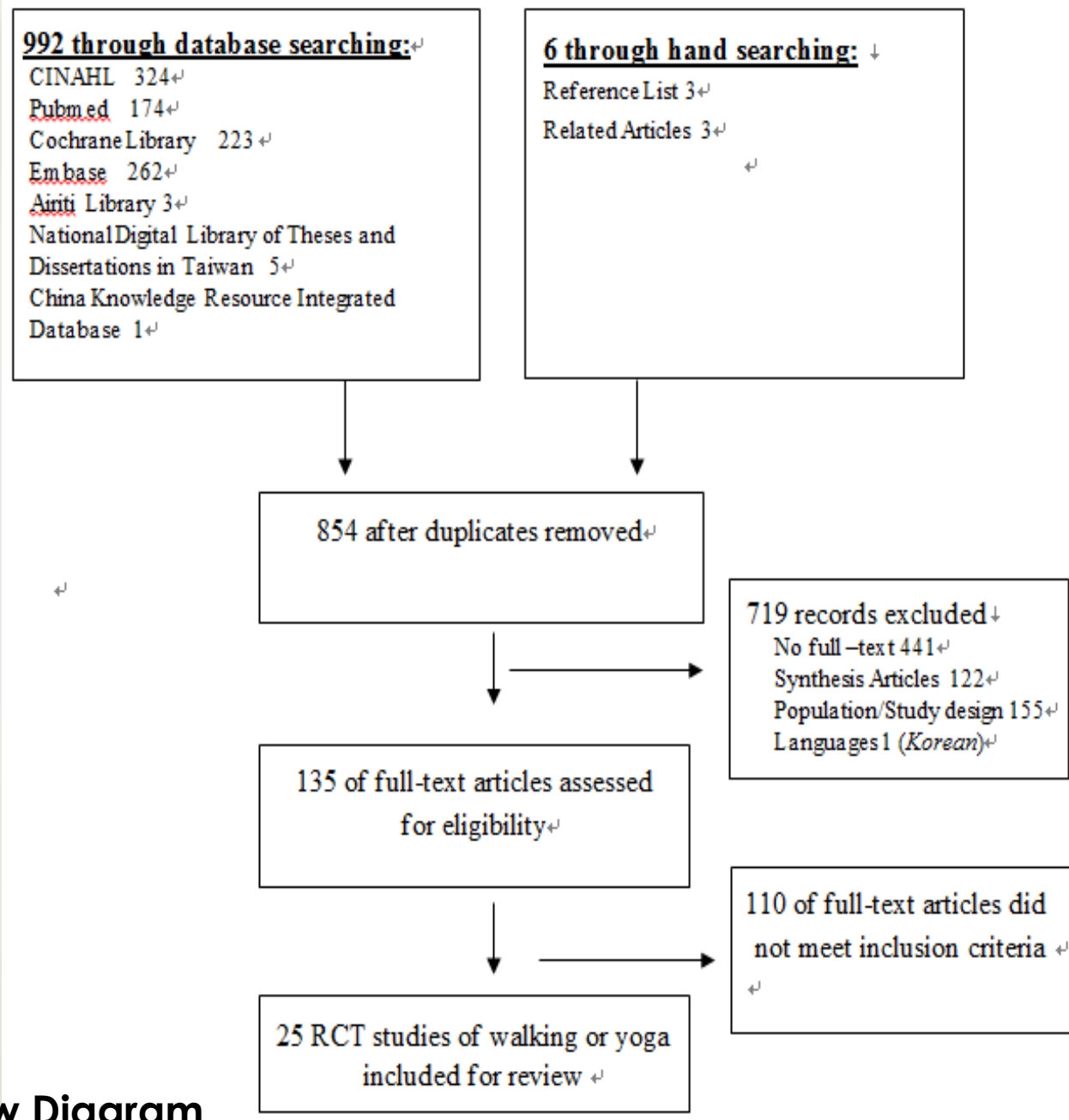


Figure S1. PRISMA Flow Diagram

Article review

- **Two reviewers** (MT, HC) **independently** evaluated the eligibility of each article according to the inclusion criteria.
- For any discrepancies, a **third independent reviewer** intervened until a consensus was reached.



Assessment of study quality Tool

- Study quality using assessment tools for the **risk of bias** from the Cochrane Handbook for Systematic Reviews of Intervention version 5.1.0 .
- were rated as “**high risk**,” “**unclear**,” or “**low risk**” by two independent reviewers.

the New England
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考科藍偏誤風險評比工具

Cochrane Risk of Bias Tool

偏誤風險	定義	項目
選擇性偏誤	組間比較有「系統性差異」	如何產生隨機分派順序？ 如何維持分派隱匿？
表現性偏誤	實驗性介入外，接受的照護、待遇有「系統性差異」	受試者、照護者是否維持盲性？
偵測性偏誤	結果量測有「系統性差異」	結果評估者否維持盲性？
削弱性偏誤	組間退出試驗有「系統性差異」	數據是否完整？
報告性偏誤	報告與未報告項目有「系統性差異」	是否選擇性報告？

資料來源: Cochrane Handbook of Systematic Review.

Assessment of risk of bias(ROB)

- some included articles were rated at a high or unclear risk of bias in terms of the domains of :
 - **Random** sequence generation (n = 5);
 - **Allocation** concealment (n = 14);
 - **Blinding** of the participants, personnel, and **outcome assessors** (n = 8);
 - **Incomplete outcome** data (n = 13);
 - However, we found no included studies with potential bias regarding the domain of **selective reporting**.

Table S2. Risk of methodologic bias score of included studies^d

	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete Outcome Data addressed	Selective reporting
Andersson A et al 2014 ²⁰⁰³	H	H	H	H	H	L
Carson JW et al 2009 ²⁰⁰³	L	L	L	L	L	L
Chandrasekaran KD et al 2010 ²⁰⁰³	L	U	H	H	L	L
Chandrasekaran KD et al 2014 ²⁰⁰³	L	U	L	L	H	L
Chaoul A et al 2018 ²⁰⁰³	L	H	H	H	L	L
Chen HM et al 2016 ²⁰⁰³	L	U	H	H	H	L
Cheville AL et al 2013 ²⁰⁰³	L	L	L	L	H	L
Cohen L et al 2004 ²⁰⁰³	L	L	H	U	H	L
Cramer H et al 2016 ²⁰⁰³	L	L	L	L	L	L
Danaher SC et al 2009 ²⁰⁰³	L	U	H	H	H	L
Donnelly CM et al 2011 ²⁰⁰³	L	L	L	L	L	L
Mock V et al 1997 ²⁰⁰³	L	U	L	L	H	L
Murphy KM et al 2013 ²⁰⁰³	L	L	L	L	L	L
Naraphong W et al 2015 ²⁰⁰³	L	U	L	L	L	L
Payne JK et al 2008 ²⁰⁰³	U	U	L	L	L	L
Ratcliff CG et al 2016 ²⁰⁰³	H	U	U	U	H	L
Rogers LQ et al 2009 ²⁰⁰³	L	L	L	L	L	L
Rogers LQ et al 2015 ²⁰⁰³	L	L	L	L	H	L
Spred LK et al 2010 ²⁰⁰³	L	L	L	L	H	L
Tang MF et al 2010 ²⁰⁰³	L	U	L	L	H	L
Taylor TR et al 2018 ²⁰⁰³	L	L	H	U	H	L
Vadivaja SH et al 2009 ²⁰⁰³	L	L	L	L	L	L
Wang CQ et al 2010 ²⁰⁰³	L	U	H	H	L	L
Wang YJ et al 2011 ²⁰⁰³	U	U	L	L	L	L
Wenzel JA et al 2013 ²⁰⁰³	U	U	L	L	H	L

H : Highrisk L : Lowrisk U : unclear^d

Table 1

Sample characteristics of walking and yoga studies in alphabetical order by first author.

Author, reference number	Country	Age: Exercise/Control (average age)	Gender: Female/Male	Cancer Type	Cancer stage	Sample size Exercise/control	Cancer treatment at enrollment	Outcome measurement
Walking								
Chen HM et al. 2011 [43]	China	64.6 ± 11.5/62.5 ± 9.6 (63.6 ± 10.6)	6/0	Lung cancer	Stage I-IV	56/55 (111)	During/after	PSQI ^a
Cheville AL et al. 2013 [48]	United States	63.8 ± 12.5/65.5 ± 8.9 (64.7 ± 10.7)	31/3	Lung cancer; colorectal cancer	Stage IV	33/33 (66)	During/after	Symptom numeric rating scales
Donnelly CM et al. 2011 [44]	United Kingdom	53.5 ± 8.7/52.1 ± 11.8 (52.8 ± 10.3)	33/0	Gynecological cancer (Ovarian/endometrial/uterine/cervical)	Stage I-III	16/17 (33)	Before/during/after	PSQI
Mock V et al. 1997 [51]	United States	48.1 ± 5.4/50.3 ± 8.5 (49.2 ± 7)	46/0	Breast cancer	Stage I-II	22/24 (46)	During only	Symptom assessment scales
Naraphong W et al. 2015 [39]	United States	46.4 ± 9.4/47.2 ± 6.9 (46.8 ± 8.2)	23/0	Breast cancer	Stage I- III	11/12 (23)	During only	General sleep disturbance scale
Payne JK et al. 2008 [19]	United States	64.7 ± 6.3	20/0	Breast cancer	Not reported	10/10 (20)	During only	PSQI
Rogers LQ et al. 2009 [53]	United States	53 ± 9	41/0	Breast cancer	Stage I- IIIA	21/20 (41)	During only	PSQI
Rogers LQ et al. 2015 [16]	United States	56.2 ± 7.7	44/0	Breast cancer	Stage I- II	22/22 (44)	During/after	PSQI
Sprod LK et al. 2010 [45]	United States	56.6 ± 13.7/63.3 ± 9.4 (60.0 ± 11.6)	27/11	Breast cancer; prostate cancer	Not reported	19/19 (38)	During only	PSQI
Tang MF et al. 2010 [20]	Taiwan	47.4 ± 10.1/56.4 ± 12.4 (51.9 ± 11.3)	54/17	All cancer diagnosis	Stage I-IV	36/35 (71)	During/after	PSQI
Wang YJ et al. 2011 [21]	Taiwan	48.4 ± 10.2/52.3 ± 8.9 (50.4 ± 9.6)	72/0	Breast cancer	Stage I-II	35/37 (72)	During/after	PSQI
Wenzel JA et al. 2010 [46]	United States	59.8 ± 10.8/60.6 ± 10.8 (60.2 ± 10.8)	49/77	Solid tumor cancer (breast/prostate/colon cancer)	Stage I-III	68/58 (126)	During only	PSQI
Yoga								
Andysz A et al. 2014 [40]	Poland	54.8 ± 7.4/58.6 ± 10.8 (56.7 ± 9.1)	28/0	Breast cancer	Stage I	12/16 (28)	During only	Global health status and quality of life scale
Carson JW et al. 2009 [36]	United States	53.9 ± 9.0/54.9 ± 6.2 (54.4 ± 7.6)	37/0	Breast cancer	Stage IA-IIIB	17/20 (37)	Before/during/after	0-9 Scales
Chandwani KD et al. 2010 [37]	United States	51.4 ± 7.9/54.0 ± 9.9 (52.7 ± 8.9)	61/0	Breast cancer	Stage 0-III	30/31 (61)	During only	PSQI
Chandwani KD et al. 2014 [47]	United States	52.4 ± 1.4/52.1 ± 1.3 (52.3 ± 1.4)	107/0	Breast cancer	Stage 0-III	53/54 (107)	During only	PSQI
Chaoul A et al. 2018 [14]	United States	49.5 ± 9.8/49 ± 10.1 (50.0)	159/0	Breast cancer	Stage I-III	74/85 (159)	During only	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	12/27	Lymphoma	Stage I-IV	20/19 (39)	During/after	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	21/33	Colorectal cancer	Stage I-III	27/27 (54)	Before/during/after	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	44/0	Breast cancer	Stage I-IV	22/22 (44)	Before/during/after	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	393/17	All cancer diagnosis	Stage I-IV	206/204 (410)	During/after	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	107/0	Breast cancer	Stage 0-III	53/54 (107)	During only	PSQI
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	33/0	Breast cancer	Not reported	18/15 (33)	During/after	Insomnia severity index
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	88/0	Breast cancer	Stage I-III	44/44 (88)	During only	EORTC QLQ-C30 ^b
Chen Y et al. 2013 [41]	China	61.7 ± 6.8 ± 10.4 (59.8)	60/0	Breast cancer	Not reported	30/30 (60)	Before/during/after	Self-rating scale of sleep

^b EORTC QLQ-C30: The European Organization for Research and Treatment of Cancer quality of life questionnaire.

Publication bias

- Potential publication bias was analyzed using **Egger's** regression and **Begg's** tests; both were negative ($p = 0.09$ and $p = 0.25$).
- There was no publication bias in the **walking** or **yoga subgroups** using Egger's test ($p = 0.56$ vs. $p = 0.48$) or Begg's test ($p = 0.84$ vs. $p = 0.43$).

Effect of walking and yoga on sleep disturbance

- The **random effects model** was applied to analyze the 25 studies, the **combined data** showed a significant improvement in sleep disturbance (SMD =0.42, 95% CI, 0.57 to 0.27).
- The **subgroup analysis** revealed that **exercise type** was the main cause of the marked heterogeneity; studies that employed **walking** as the intervention showed **greater improvement** in sleep disturbance **than** studies that used **yoga** as the intervention (SMD = 0.62 vs. 0.26 ; $p = 0.01$).

0.009

Sensitivity analyses

- sensitivity analyses were performed by excluding the study with the largest effect size.
- The result remained statistically significant ($SMD = 0.38$, 95%CI, 0.52 to 0.24).



Table 2

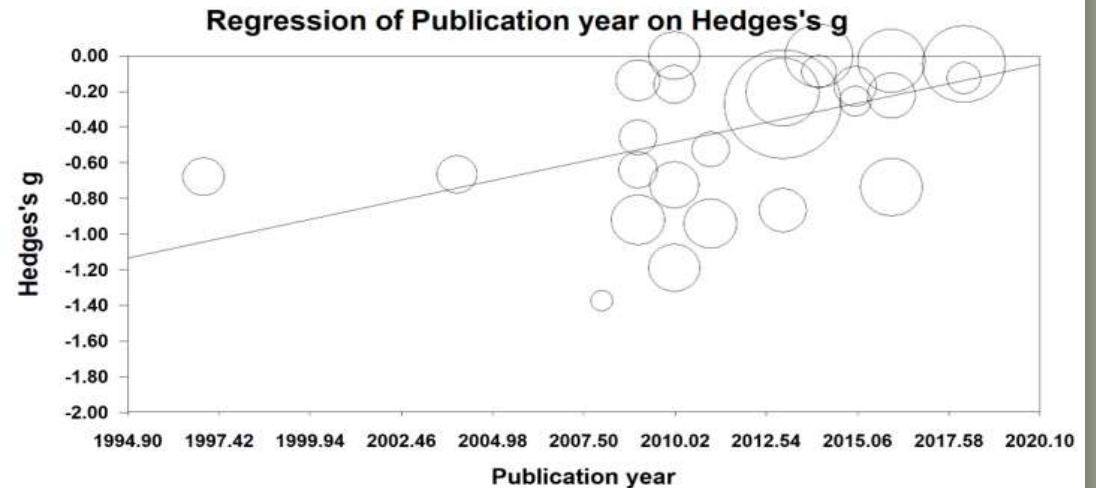
Mean effect sizes, moderator analyses, and quality analyses of included studies.

Parameter	k	Effect Size (Hedges' g)	95% CI	p
Categorical Moderators				
Random sequence generation				
Low risk	20	−0.43	−0.59, −0.27	0.97
High/unclear risk	5	−0.42	−0.84, 0.00	
Allocation concealment				
Low risk	11	−0.44	−0.61, −0.27	0.84
High/unclear risk	14	−0.41	−0.64, −0.18	
Cancer type				
Breast cancer	16	−0.36	−0.57, −0.17	0.33
Others	9	−0.52	−0.77, −0.28	
Type of intervention				0.01*
Walking exercise	12	−0.62	−0.84, −0.40	
Yoga exercise	13	−0.26	−0.42, −0.10	
Outcome measurement				
PSQI	17	−0.37	−0.54, −0.19	0.09
Others	8	−0.61	−0.83, −0.39	
Cancer treatment at enrollment				
During only	12	−0.27	−0.48, −0.07	0.05
Before/during/after	13	−0.55	−0.75, −0.36	
Parameter	K	β	95% CI	P
Continuous Moderators				
Age	24	−0.01	−0.03, 0.01	0.42
Duration per session	24	−0.01	−0.04, 0.02	0.46
Adherence rate	24	0.00	−0.01, 0.01	0.64
Percentage of Female participants	25	0.00	−0.00, 0.01	0.17
Frequency per session	24	0.03	−0.02, 0.08	0.22
Sample size	25	0.00	−0.00, 0.00	0.11
Publication date	25	0.04	0.02, 0.07	0.00*

Regression analysis

- ➔ Regression analysis of study **publication dates** revealed a **positive correlation** with study effect size ($p < 0.001$).

Table S5. Regression of publication year on Hedge's g



Fixed effect regression

	Point estimate	Standard error	Lower limit	Upper limit	Z-value	p-Value
Slope	0.04305	0.01241	0.01873	0.06738	3.46890	0.00052
Intercept	-87.01588	24.97780	-135.97146	-38.06029	-3.48373	0.00049
Tau-squared	0.04474					

	Q	df	p-value
Model	12.03324	1.00000	0.00052
Residual	40.26484	23.00000	0.01435
Total	52.29808	24.00000	0.00072

Table S3. Mean Effect Sizes and Moderator Analyses of Walking[↵]

Parameter [↵]	k [↵]	Effect Size [↵] (Hedges'g) [↵]	95%CI [↵]	p [↵]
Categorical Moderators[↵]				
Random sequence generation [↵]	↵	↵	↵	↵
Low risk [↵]	9 [↵]	-0.63 [↵]	-0.86, -0.40 [↵]	↵
High/unclear risk [↵]	3 [↵]	-0.72 [↵]	-1.38, -0.06 [↵]	0.80 [↵]
Allocation concealment [↵]	↵	↵	↵	↵
Low risk [↵]	5 [↵]	-0.49 [↵]	-0.77, -0.20 [↵]	↵
High/unclear risk [↵]	7 [↵]	-0.72 [↵]	-1.04, -0.40 [↵]	0.28 [↵]
Cancer type [↵]	↵	↵	↵	↵
Breast cancer [↵]	6 [↵]	-0.64 [↵]	-0.94, -0.33 [↵]	↵
Others [↵]	6 [↵]	-0.61 [↵]	-0.95, -0.28 [↵]	0.92 [↵]
Outcome measurement [↵]	↵	↵	↵	↵
PSQI [↵]	9 [↵]	-0.62 [↵]	-0.90, -0.34 [↵]	↵
Others [↵]	3 [↵]	-0.67 [↵]	-1.04, -0.31 [↵]	0.82 [↵]
Cancer treatment at enrollment [↵]	↵	↵	↵	↵
During only [↵]	6 [↵]	-0.41 [↵]	-0.68, -0.14 [↵]	↵
Before/during/after [↵]	6 [↵]	-0.77 [↵]	-1.04, -0.51 [↵]	0.06 [↵]
Type of Walking intervention [↵]	↵	↵	↵	↵
Walking alone [↵]	8 [↵]	-0.71 [↵]	-0.99, -0.42 [↵]	↵
Walking combine with other forms of intervention [↵]	4 [↵]	-0.45 [↵]	-0.79, -0.10 [↵]	0.25 [↵]
Parameter [↵]	K [↵]	β [↵]	95% CI [↵]	P [↵]
Continuous Moderators[↵]				
Age [↵]	12 [↵]	0.01 [↵]	-0.02, 0.04 [↵]	0.47 [↵]
Duration per session [↵]	12 [↵]	-0.03 [↵]	-0.08, 0.02 [↵]	0.31 [↵]
Adherence rate [↵]	12 [↵]	0.03 [↵]	0.01, 0.05 [↵]	0.00* [↵]
Percentage of female participants [↵]	12 [↵]	-0.00 [↵]	-0.01, 0.00 [↵]	0.24 [↵]
Frequency per session [↵]	12 [↵]	0.11 [↵]	-0.00, 0.22 [↵]	0.05 [↵]
Sample size [↵]	12 [↵]	0.00 [↵]	-0.00, 0.01 [↵]	0.45 [↵]

Table S4. Mean Effect Sizes and Moderator Analyses of Yoga

Parameter	k	Effect Size (Hedges'g)	95% CI	p
Categorical Moderators				
Random sequence generation				
Low risk	11	-0.30	-0.48, -0.11	0.19
High/unclear risk	2	-0.04	-0.38, 0.29	
Allocation concealment				
Low risk	6	-0.43	-0.68, -0.19	0.04*
High/unclear risk	7	-0.11	-0.28, 0.06	
Cancer type				
Breast cancer	10	-0.24	-0.45, -0.02	0.66
Others	3	-0.30	-0.50, -0.11	
Outcome measurement				
PSQI	8	-0.16	-0.29, -0.03	0.03*
others	5	-0.55	-0.87, -0.23	
Cancer treatment at enrollment				
During only	6	-0.17	-0.44, 0.10	0.31
Before/during/after	7	-0.33	-0.50, -0.17	
Type of yoga intervention				
Integrated yoga	3	-0.30	-0.84, 0.24	0.73
Hatha yoga	2	-0.18	-0.60, 0.25	
	K	B	95% CI	P
Continuous Moderators				
Age	12	0.00	-0.03, 0.03	0.91
Duration per session	12	0.02	-0.02, 0.07	0.29
Adherence rate	12	-0.01	-0.03, 0.00	0.08
Percentage of Female participants	13	0.00	-0.00, 0.01	0.35
Frequency per session	12	0.01	-0.04, 0.06	0.71
Sample size	13	0.00	-0.00, 0.00	0.95

Discussion

- **Regular exercise** could ameliorate the burden of sleep disturbance in cancer patients.
- The effect of **walking** for reducing sleep disturbance in cancer patients is **superior to yoga**.
- We found that the study **publication date** exhibited a **positive correlation** with the intervention effect. This could be explained due to the fact that the **recently conducted studies might have more rigorous study designs**; therefore, the interventions yielded more desirable outcomes.

Recommendations for practice-1

- First, an **8-wk program of three weekly sessions of moderate-intensity walking** can be advised for patients with different cancer diagnoses and at all treatment stages.
- Second, walking can be prescribed as an **independent intervention** and used in **combination with other forms** of exercise.
- Third, exercise can have **adverse effects** in patients with **cardiovascular** and **respiratory impairments**. therefore, these patients should be carefully **evaluated** using **lung function tests** and **exercise electrocardiography** prior to any exercise intervention.



Recommendations for practice-2

- The public should be **educated about the sleep-related benefits** of **moderate-intensity walking**, and exercise **should be promoted** in hospitals and the community.
- **Overtraining** can cause distress to the **central nervous system**, which may lead to sleep pattern changes and sleep disturbance.



Conclusion

- Walking is generally more effective than yoga at improving sleep in cancer patients.
- Moderate-intensity walking can be advised in patients with different cancer diagnoses and at all treatment stages.
- Walking and yoga are **generally safe** for most cancer patients; however, **close monitoring** and supervised exercise sessions are required **for high-risk patients**, especially those with **cardiac or pulmonary comorbidities**.

